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7/07/05

10/519828

USPTO Rec'd PCT/PTO 30 DEC 2004

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Manufacturing device, particularly a folding press, having electronic tool detection

The invention relates to a production unit, in particular a bending press, for forming work-pieces of sheet metal, of the type outlined in the introductory part of claim 1.

Patent specifications DE 38 24 734 A1 and DE 38 30 488 A1 disclose a production unit 1 for processing metal, in particular a die bending machine or a die forging press, with an electronic tool detection system. A set of bending tools for these units consists of at least a top tool, in particular a stamp, and a bottom tool, in particular a die. However, these tools can also be split up into segments, i.e. separated, so that the smaller tool parts are easier to handle. At least one electronically detectable code carrier is mounted in the respective individual tools, which contains all the geometric data defining the tool and the permissible tool load data. Alternatively, the code carrier may also be defined by nothing more than a tool code if the tool data is stored in the machine controller. In order to be able to read the code carriers in the tools, at least one reading head is mounted respectively in the region of the tool holder mechanisms, i.e. on the press beam and on the press table. These reading heads provided for each code carrier enable the tool data or tool codes of the individual code carriers to be detected and transmitted to the machine controller. The disadvantage of this is that it is necessary to provide a plurality of reading heads in order to detect one of a plurality of possible work tools for every bending tool,

which means that a relatively complex cabling and wiring system is needed, amongst other things. In addition, situations may arise in which a new set of bending tools does not match the disposition of the reading heads because of a different pitch distance, so that either the disposition of the individual reading heads has to be changed or the positioning of the code carrier on the bending tools has to be adapted, which then requires a series of awkward manipulations.

The underlying objective of the present invention is to propose a production unit for forming workpieces of sheet metal, which permits a reliable identification and/or position detection of the inserted bending tools, even if there is a plurality of different configurations, thereby obviating the need for any complex re-fitting or adaptation work on the tool detection system, in particular with regard to its structure.

This objective is achieved by the invention as a result of the technical characteristics of a production unit as defined in claim 1.

One advantage achieved as a result of the features specified in the characteristic part of claim 1 is that only a single detection system is needed for the electronic information carriers to enable the bending tools of the press beam and./or the press table to be electronically detected. Furthermore, hardly any re-fitting work is needed in order to ensure that the individual bending tools provided for any work application can be reliably detected in different tool configurations. All in all, the specified production unit is therefore particularly flexible in terms of the possible tool distances or number of tools and the electronic detection of them is reliable. Another particular advantage is the fact that, because the detection device is forcibly guided during its displacement, the individual tool data sets or tool codes can be detected in a consecutive sequence, which means that the sequence of whatever bending tools are inserted can be easily detected by the control device. This detection takes place without an exactly defined specification having to be entered at the electronic control device. Another advantage of the design proposed by the invention resides in the fact that the individual information carriers are read in sequence, which means that the maximum number of detectable tools is no longer restricted by hardware-related constraints, such as a limited number of available inputs, for example. The number of detectable bending tools can therefore be extended with relatively little difficulty. The specified design also facilitates and improves the task of detecting the

position of the individual bending tools. Accordingly, the position can be detected in combination with or as an alternative to identification of the tools themselves.

Another embodiment defined in claim 2 is of advantage because it permits a reliable signal and data transmission from the detection device to the control device and vice versa, if necessary, and the risk of outside influences is low or can be minimised by simple technical means such as screening means, for example.

Also of advantage is another embodiment defined in claim 3, because it enables a relatively wide displacement range within which a signal and data transmission can be reliably run, whilst requiring very little in the way of wiring and cabling.

Of particular advantage are the features defined in claim 4, because they provide a simple means of ensuring that the respective data and codes of the majority of information carriers can be passed consecutively in sequence alongside the detection device or recorded by it. This therefore minimises the risk of incorrect detection and is also conducive to detecting the sequence and disposition of the individual tools.

Advantage is also to be had from an embodiment defined in claim 5, since it enables larger displacement paths and tool lengths to be bridged without difficulty and makes for an inexpensive displacement and/or guide system.

Another embodiment based on one of the alternative designs characterised in claim 6 is also of advantage because it lends itself to a simple mechanical construction by means of which the detection device can be moved across wide stretches with sufficient guiding accuracy, given the dimensions of the detection device.

An alternative embodiment is defined in claim 7. The advantage of this is that it offers a relatively precise forced guiding action for the detection device along the possible tool length.

Of particular advantage is an optional embodiment defined in claim 8, since it enables the detection device to be at least partially or predominantly automated.

As a result of the optional embodiment defined in claim 9, a bi-directional displacement of the detection device can be automated. Furthermore, by designing a cable link accordingly, twisting in the cable which is likely to cause damage can be ruled out, in addition to which, the individual information carriers can be scanned twice or more within a relatively short time.

As a result of the embodiment defined in claim 10, the demands placed on the displacement and guide device are low and the occurrence of wear due to components rubbing or sliding against one another is ruled out.

The virtually maintenance-free electronic information carrier defined in claim 11 is of advantage in terms of keeping costs down.

As a result of the embodiment defined in claim 12, at least the communication and transmission run for information and data signals between the detection device and the information carrier can be of a contactless or wireless design. It is also preferable if electric operating power for the passive information carrier is transmitted wirelessly between the detection device and the information carriers via these transmitter and/or receiver devices or alternatively via separate transmitter and/or receiver units. Furthermore, information carriers of this type can also be read or detected without any difficulty, even if the guiding or displacement accuracy of the displacement and/or guide device is low.

Another possible embodiment defined in claim 13 is of particular advantage because changing data and cumulative historical data can be stored via the detection device in the memory device as and when necessary, which means that the information carriers will always contain up to date information and data.

Another possible embodiment is defined in claim 14, the advantage of which is that, although simple means are used, the relative position of bending tools within the possible length within which tools can be mounted is determined sufficiently accurately. This advantageously means that there is no need to make any adjustments or modifications to the bending tools or position-detecting elements.

Claim 15 specifies an inexpensive passive position-detection element which can be reliably detected.

The embodiment defined in claim 16 enables contactless detection of the presence and/or position of a bending tool, using inexpensive but reliable means.

As a result of the embodiment defined in claim 17, the instantaneous position of a specific tool within the possible tool length can be detected, for example from a defined tool initial point, so that it can be evaluated and taken into account in the subsequent sequences to be run.

A multi-use or multi-functional use of the displacement drive is made possible by the embodiment defined in claim 18, namely for detecting the position of various bending tools on the one hand and as a displacement drive for automating the displaceable detection device, on the other.

As a result of the embodiment defined in claim 19, there is no need for trailing cable systems between the displaceable detection device and a stationary machine part, which also means that a reliable hard-wired signal transmission is possible from the displaceable detection device to a fixed or stationary point of the production unit, even if there is limited space.

Electric signals can be reliably and simply transmitted from the transport element to the control device and/or vice versa as a result of the embodiment defined in claim 20 and/or 21.

As a result of the features defined in claim 22, a reliable electrical isolation is obtained between the transport elements and the machine frame using simple means.

Finally, an embodiment defined in claim 23 is of advantage because it guarantees a slip-free displacing motion of the detection device along the requisite tool length and simple technical means are used to define and monitor a displacement path of the detection device relative to the tool length and relative to a defined zero or initial point.

Instead of mounting the pulley blocks 56, 57 on horizontally oriented rotation axes 62, 63, it would naturally also be possible to provide vertically oriented rotation axes 62, 63 for the pulley blocks 56, 57. Especially if the pulley blocks 56, 57 are mounted so that they are virtually lying down, a half or a strand of the circulating transport element 55 may also be guided outside of the load-bearing machine frame 5.

As also schematically illustrated, the rotation axes 62, 63 for the pulley blocks 56, 57 may be mounted between the top face of the table top 60 and the bottom face of the tool holding mechanism 35. This simplifies assembly and provides unhindered access to the displacement and/or guide mechanism 45 for any maintenance or modification work which might be needed and/or for control purposes.

The groove-shaped recess 59 in the tool holder mechanism 35 may also be of a stepped design, starting from the top face of the tool holder mechanism 35 in the direction towards the floor, on which the machine frame 5 stands in order to mount or support a plate-type cover element 64. This removable cover element 64 which may be placed in and removed from the recess 54 as and when necessary results in a virtual spatial division in the recess 59 between a top tool-holder groove 65 and the housing or hollow compartment 61 disposed underneath, which is provided as a means of accommodating at least the belt- or cable-type flexible transport element 55 along with the detection device 44.

The plate-shaped cover element 64 between the hollow compartment 61 and the tool holder groove 65 for the bending tools 36 prevents or minimises the amount of dirt which is able to reach the transport element 55 and the detection device 44 lying underneath the bending tools 36. This separating or cover element 64 between the tool holder groove 65 and the hollow compartment 61 for the detection device 44, which is relatively displaceable therein, also prevents the detection device 44 from becoming hooked on the bending tools 36 and the information carriers 63 as the transport mechanism 44 is guided relatively close alongside the information carriers 43 and the bending tool 36. The cover element 64 can then be removed, providing an easy means of gaining access to the detection device 44 and transport element 55 and/or the other components of the displacement and/or guide mechanism 45.

## C l a i m s

1. Production unit (1), in particular a bending press (2), for forming workpieces (3) of sheet metal, having two press beams (15, 16) which are displaceable relative to one another by means of a drive mechanism (53) and can be used to obtain a required tool length (42) by fitting a variable number of bending tools (36, 37), and having a control device (46) connected to the drive mechanism (53) for influencing the operating behaviour of the production unit (1) as a function of states detected by sensors, manual control commands and/or specifications stored in a memory device, in which the inserted bending tools (36, 37) have at least machine-readable unmistakable codes in the form of electronically detectable information carriers (43) for identifying them and/or detecting their position on an at least partially automated basis, characterised in that an electronic detection device (44) connected to the control device (46) or to a control and/or evaluation device (47) co-operating with it for detecting a plurality of information carriers (43) co-operates with the first and/or second press beam (15; 16), and at least one displacement and/or guide mechanism (45) is provided which extends essentially parallel with the achievable tool length (42) and accommodates the detection device (44) so that the codes or data and/or detection signals of a plurality of information carriers (43) can be detected in sequence during a relative displacement of the detection device (44) along the displacement and/or guide mechanism (45) and can be transmitted to the control device (46) or the control and/or evaluation device (47) co-operating with it.
2. Production unit as claimed in claim 1, characterised in that the detection device (44) is coupled with the control and/or evaluation device (47) via a line connection (48) so as to transmit signals.
3. Production unit as claimed in claim 2, characterised in that the line connection (48) is provided in the form of a trailing cable system (49) disposed within the displacement and/or guide range of the detection device (44).
4. Production unit as claimed in one or more of the preceding claims, characterised in that a maximum detection distance (82) between the displaceably mounted detection device (44) and an information carrier (43) of an adjacent bending tool (36; 37) is shorter than a smallest possible distance (83) between two information carriers (43) of bending tools (36;

37) lined up in a row adjacent to one another without any gaps.

5. Production unit as claimed in one or more of the preceding claims, characterised in that the displacement and/or guide mechanism (45) is a flexible transport element (55) to which the detection device (44) is attached.

6. Production unit as claimed in claim 5, characterised in that the flexible transport element (55) is guided round two mutually spaced pulley blocks (56, 57) or winding spools.

7. Production unit as claimed in one or more of claims 1 to 4, characterised in that the displacement and/or guide mechanism (45) has a guide element (50) with a guide carriage (51) relatively displaceable thereto, on which the detection device (44) is disposed.

8. Production unit as claimed in one or more of the preceding claims, characterised in that the displacement and/or guide mechanism (45) has a displacement drive (58) connected to the control device (46).

9. Production unit as claimed in claim 8, characterised in that the displacement drive (58) can be reversed in its direction of rotation or motion.

10. Production unit as claimed in one or more of the preceding claims, characterised in that the information carriers (43) are transponders (77) which can be detected contactlessly or without being touched.

11. Production unit as claimed in claim 10, characterised in that the transponders (77) operate without batteries.

12. Production unit as claimed in claim 10 or 11, characterised in that the transponders (77) can be inductively or electromagnetically coupled with the detection device (44) via corresponding transmitter and/or receiver devices (52) for electromagnetic waves.

13. Production unit as claimed in one or more of the preceding claims, characterised in that the detection device (44) is able to intervene by reading and writing to a non-volatile

memory device (81) of the information carriers (43) or transponders (77).

14. Production unit as claimed in one or more of the preceding claims, characterised in that the information carriers (43) have a passive position detection element (69).

15. Production unit as claimed in claim 14, characterised in that the position detection element (69) is provided in the form of a metal screen (71) or another metal element on the information carrier (43).

16. Production unit as claimed in one or more of the preceding claims, characterised in that the detection device (44) has an inductive sensor (72), in particular a Hall-effect sensor, for detecting a metal screen (71) or another metal element on or in the region of an information carrier (43).

17. Production unit as claimed in one or more of the preceding claims, characterised in that the detection device (44) or control and/or evaluation device (47) has a distance measuring device (73) which measures the displacement path travelled by the detection device (44).

18. Production unit as claimed in one or more of the preceding claims, characterised in that the displacement and/or guide mechanism (45) is a displacement drive (58) and has a stepper motor (74) connected to the control and/or evaluation device (47) for determining the displacement path and/or controlling the displacement path.

19. Production unit as claimed in one or more of the preceding claims, characterised in that the flexible transport element (55) has at least one electric conductor track (68) which has an electrical connection to the detection device (44).

20. Production unit as claimed in claim 19, characterised in that the conductor track (68) on the transport element (55) is connected to a stationary slide contact (67) so as to pick up and/or transmit electric signals from and to the detection device (44) in a sliding connection.

21. Production unit as claimed in claim 20, characterised in that the slide contact (67) is connected to the control and/or evaluation device (47).

22. Production unit as claimed in claim 19 or 20, characterised in that contact can be made with the conductor track (68), which is electrically isolated from the pulley blocks (56, 57), from the top face of the transport element (55).

23. Production unit as claimed in claim 1, characterised in that the displacement and/or guide mechanism (45) has a spindle drive (84) on which the detection device (44) is mounted and is displaceable in two directions along the possible tool length (42) by a reversible rotating motion of a threaded spindle (85) of the spindle drive (84).